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EVA Swab Tool to Support Planetary Protection and Astrobiology Evaluations

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Background

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Issue: We have knowledge gaps!

- Weather/how microbes are released from crewed pressure systems

Strategic Knowledge
Gap B5
*Forward Contamination
for Mars*

Why do we care?

- Informs Mars operational concepts
 - Informs architecture decisions
 - Informs landing site selection decisions
- *How to protect the science*
 - *Open vs. closed life support systems?*
 - *How close can we operate to where life may be present?*



First, We Need A Toolbox

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Microbial sampling on Earth is simple

Sterile, wetted swab



Sampling in space is more complicated

Difficult to handle swab with bulky gloves

Wetted swab won't work in a vacuum

Sample container has to maintain integrity when transiting from vacuum to pressure cabin

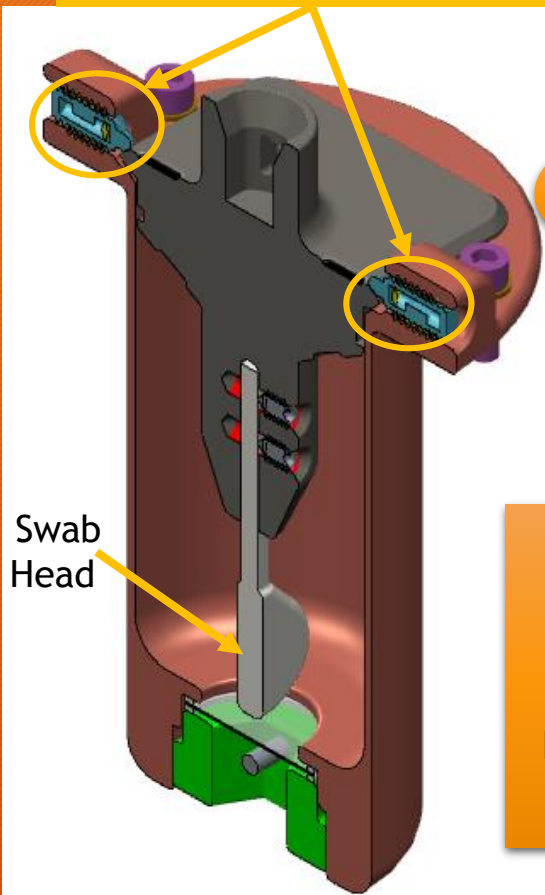


Extravehicular Activity (EVA) Gloves

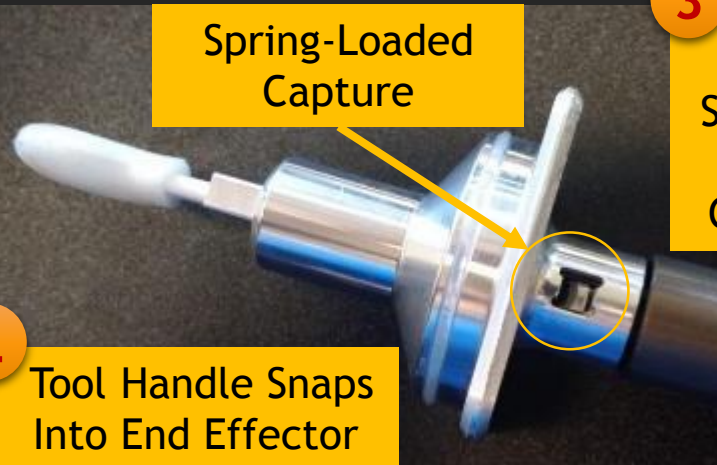
Swab Tool Is Designed for EVA

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1 Swab Tip Held in Sterile Container with Ball Detents



2 Tool Handle Snaps Into End Effector



3 Pull to remove Swab from Sterile Container



4 Slide Cover Forward and Squeeze Paddles to Release Swab Tip



Simple push-fit to engage swab tip, but dual-action required to release swab tip

Tether Loop



8-Sample Swab Kit

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0.22 micron pore
Microbial filter stackin
bottom of each sample
canister allows canisters
to vent but remain sterile



6 canisters on top, 2 on bottom (not shown)



Tool Form, Fit, Function Tests

Suit differential pressure

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Lab Environment (Not Vacuum Chamber)

Form, Fit, Function Testing

- Suited subject in a Mark III suit at differential suit pressure

Swab Tip Environmental Testing

- Macrofoam + two other types of swab
- Bend and pull tests at temperatures from -73.3°C (-100°F) to 37.8°C (100°F)
- Testing indicated swabs would maintain integrity under expected loading, even at temperature extremes

Swab Tip Effectiveness

- Tests at JPL and JSC demonstrated dry macrofoam swab was at least as effective as standard wetted swabs



Extravehicular Mobility Unit (EMU)

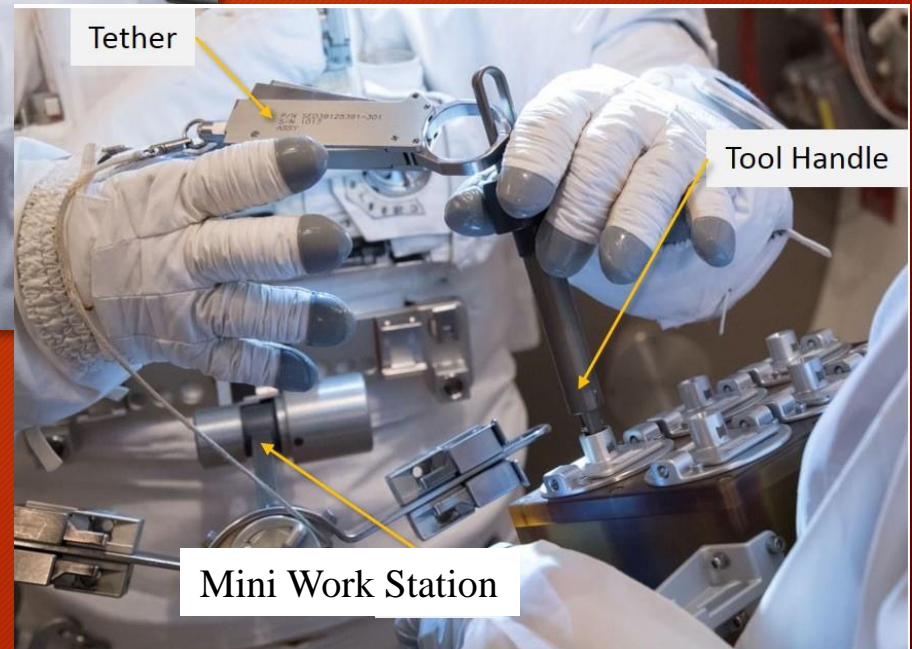
Suit differential pressure

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We need to characterize the suits before we send suited crew to sample anything else

Saved cost by piggy-backing onto EMU-suited ISS crew training runs





EMU Wrist Joint Swabbing

4.3 psi differential suit pressure

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Initial tests: did not modify any suit cleaning or handling protocols

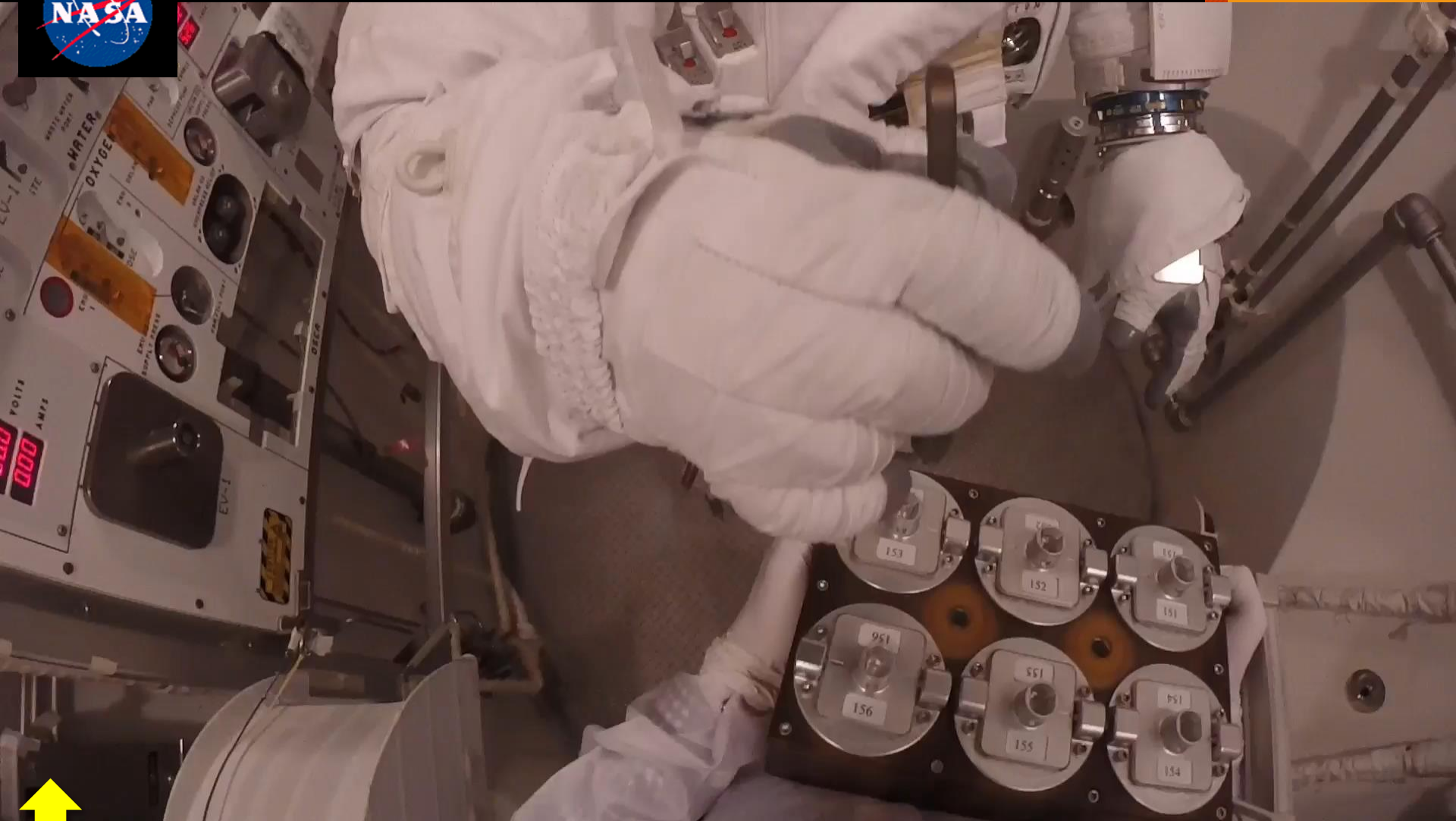


Suit joints & vents are the most likely microbial escape paths

- Microbes only need 0.5 to 1.0 μm gap
- Vents can be filtered, but joints can't

Evaluations with EMU Suits

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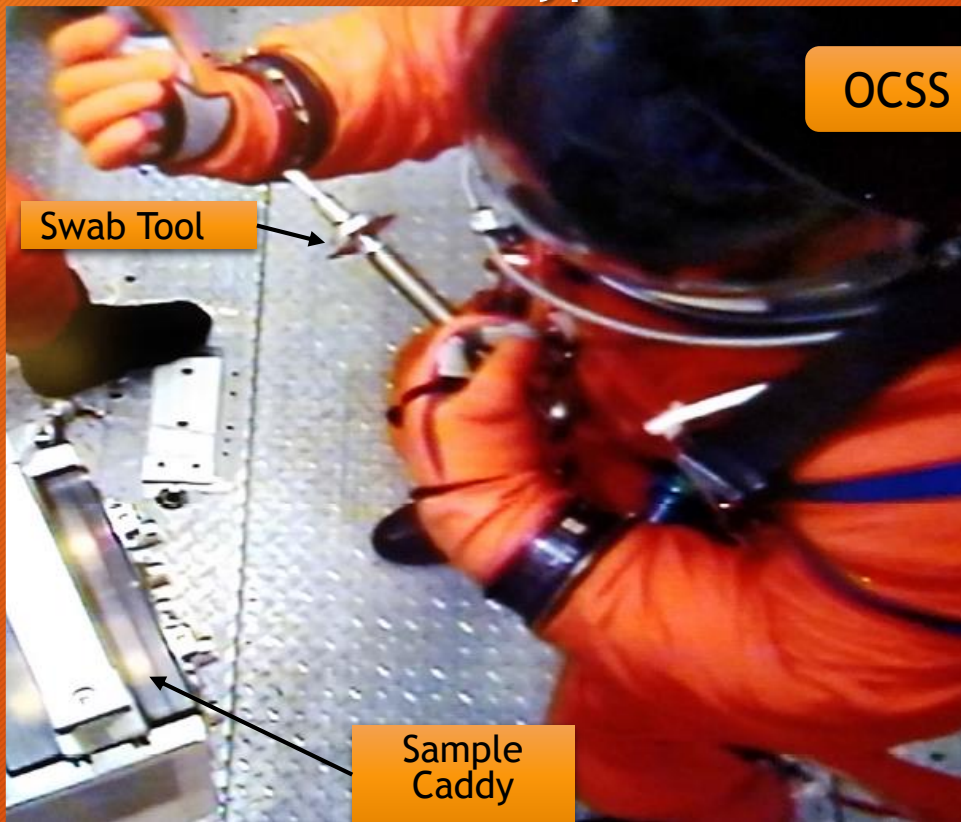
[Click here to play video](#)



External Vacuum Swab Test

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- Piggy-backed onto a 6-test Orion project series
 - Two different types of suits

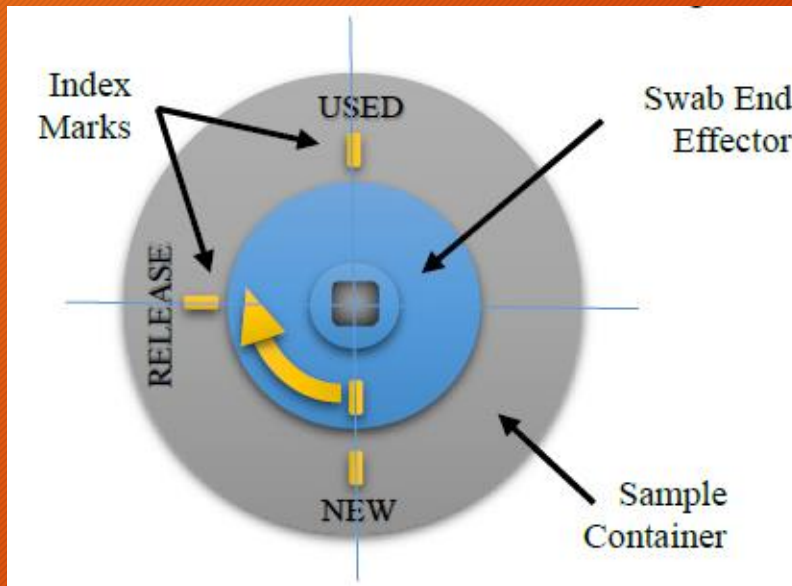




Design Improvements

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- *End Effector-to-Canister Seal Redesign*
 - Seal retaining ring, alternate seal profile, or alternate seal type
- *End Effector Locking Device*
 - To ensure end effectors remain inside canisters during handling or shipping



- *Swab Re-Use Prevention*
 - Ratcheting device to prevent inadvertent re-use of a swab
- *Additional Caddy Handle*
 - For better operator control

Will be incorporated into flight design



Next Steps

Analysis, flight certification, and ISS swab

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Culture and DNA analysis in progress



- Will feed results back to suit designers and publish test data
- Working with CASIS to identify potential commercial partners
 - Companies interested in looking for extremophiles outside ISS

NASA@WORK

ISS is seeking ideas for additional research that could be conducted after USOS increases to 4 crew (after September, 2017)



From: InnoCentive [mailto:no-reply@innocentive.com]

Sent: Thursday, August 24, 2017 4:44 PM

Subject: Award Announcement for NASA@work Challenge: Submit Your Research Idea to be Conducted on ISS!: Congratulations!

Congratulations, your submission to NASA@work Challenge: 2270 - has been awarded!

- Payload integration agreement in place for 2018



Conclusions

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- **Ground testing validated tool effectiveness and interface with pressurized EVA suits**
 - Test subjects found tool straightforward to operate
 - Design improvements identified
 - Minimized development costs by repurposing retired hardware and piggy-backing onto flight crew training
 - Additional potential uses identified: astrobiology research and micrometeoroid/orbital debris evaluation
- **Baseline suit microbial data collected**
 - Supports development of human mission planetary protection protocols



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Questions?

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